Spring 6-13-2013

Energy efficient biogas upgrading by anaerobic hydrolysis

Rolf Jung
Fraunhofer UMSICHT

Energy efficient biogas upgrading by anaerobic hydrolysis

BioEnergy IV:

Innovations in Biomass Conversion for Heat & Power, Fuels and Chemicals

June 9-14, 2013

Basiliani Resort, Otranto, Italy

Rolf Jung

Fraunhofer UMSICHT, Institute branch Sulzbach-Rosenberg

Fraunhofer UMSICHT

Our motivation …



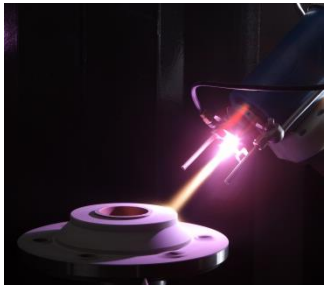



Energy conversion and storage







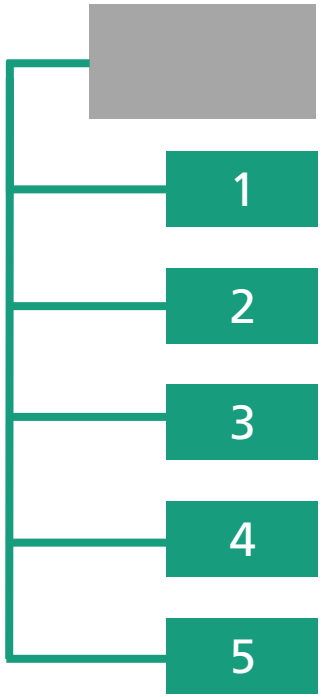


Raw and functional materials

Fraunhofer
UMSICHT

AGENDA

- Introduction
- Background
- Materials and Methods
- Results and Discussion
- Conclusions



Fraunhofer
UMSICHT

INTRODUCTION

1
2
3
4
5

Fraunhofer
UMSICHT

Introduction

Motivation

- Strong growth of biogas plants
- Biomethane can be stored or fed into the public natural gas grid
- Efficient energy usage via public grid
- Biogas upgrading is an energy intensive process
- Carbon dioxide reduction before biogas upgrade
  increase efficiency and decline costs

Fraunhofer
UMSICHT

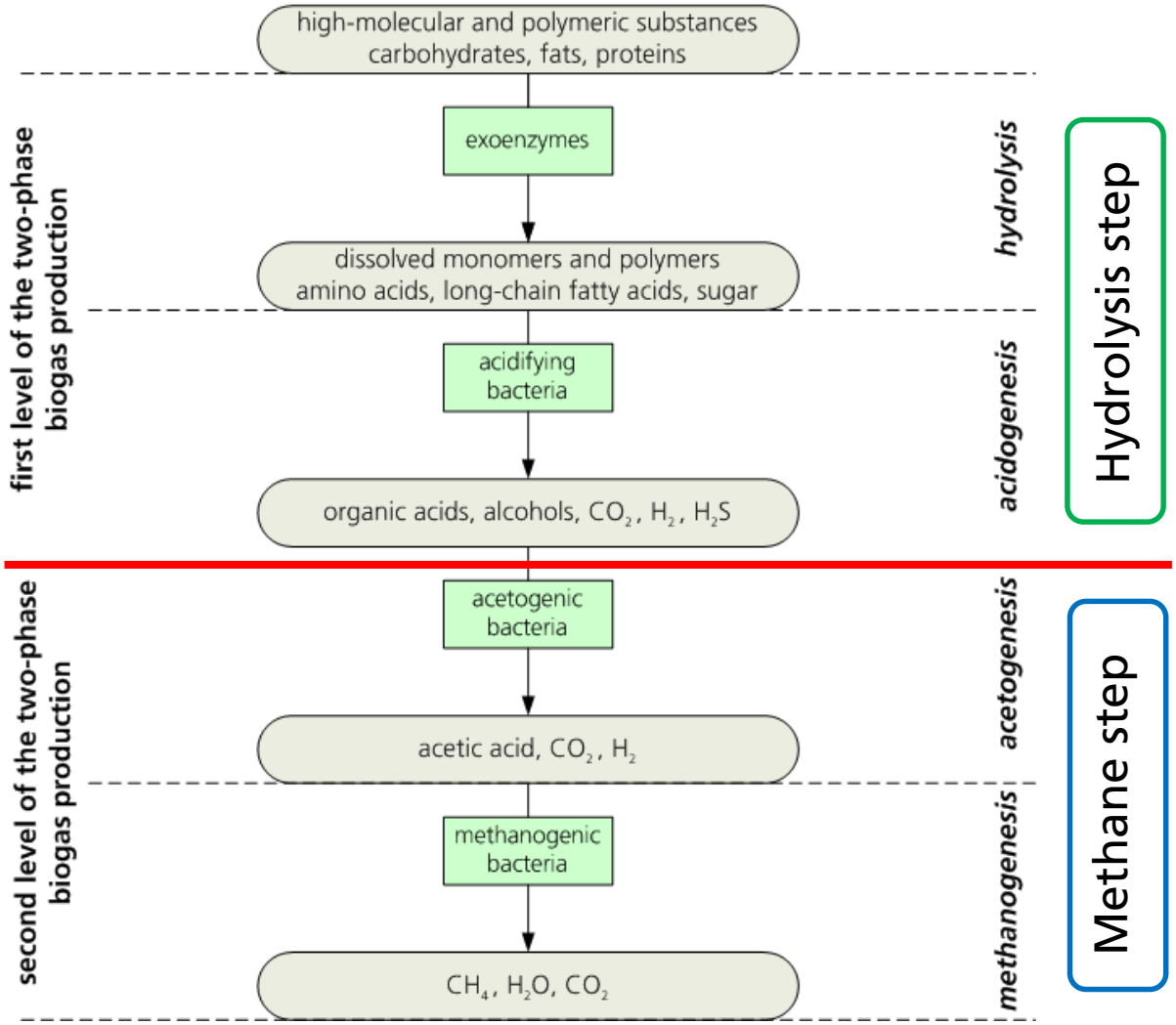
BACKGROUND

Background

Anaerobic process steps

pH-value acidic

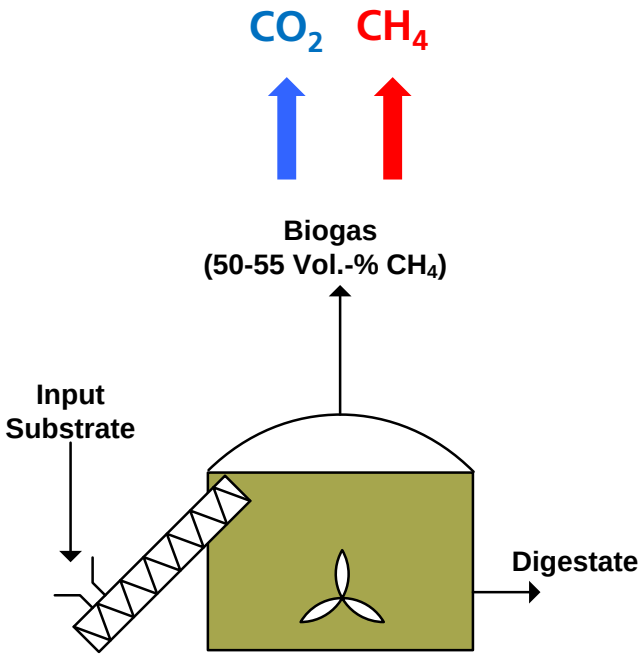
pH-value neutral



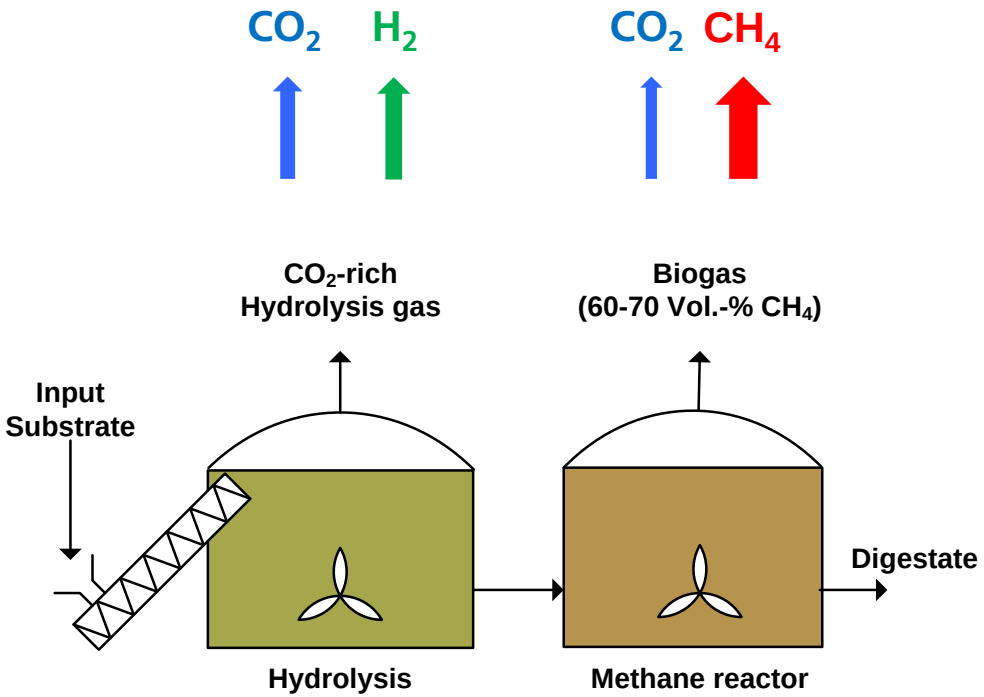
Fraunhofer UMSICHT

Background

One-phase and two-phase digestion



One-phase digestion



Two-phase digestion

Fraunhofer UMSICHT

Background

Process key parameters for hydrolysis step

- Hydraulic retention time (HRT)
- Temperature
- pH-value
- Organic loading rate

Fraunhofer UMSICHT

MATERIALS AND METHODS

1

2

3

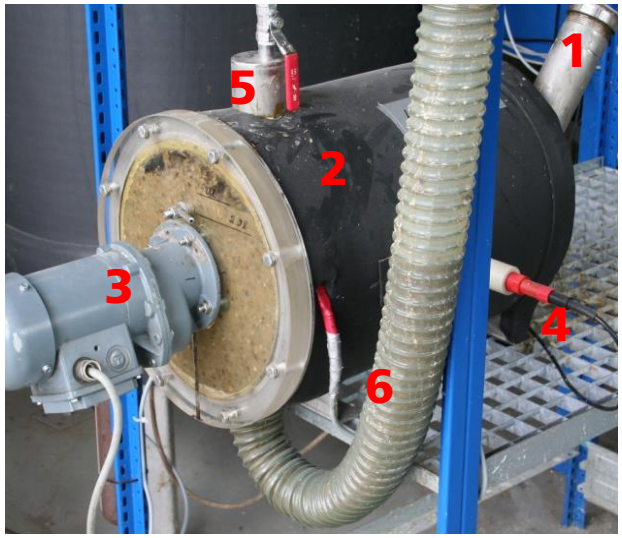
4

5

Fraunhofer UMSICHT

Materials and methods

Experimental setup



Hydrolysis reactor

V_R = 22 l

(1) Input

(2) Reactor

(3) Stirrer

(4) pH value

(5) Gas outlet

(6) Output

Methane reactors

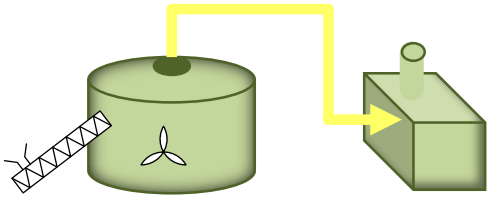
V_R = 45 l

Fraunhofer UMSICHT

Materials and methods

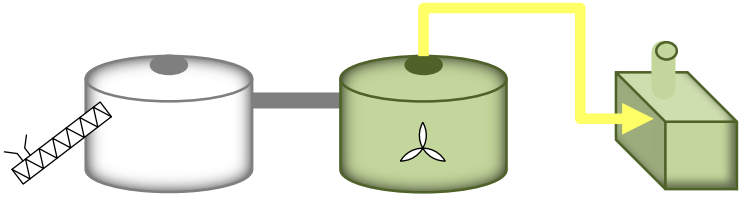
Experimental parameters

One-phase digestion



- Substrate: maize silage
- Temperature: 39 °C
- Retention time: 20 d
- Organic loading rate: 1 $kg_{oDM}/(m^3 \cdot d)$

Two-phase digestion



- Substrate: maize silage
- Temperature: 39 °C

Hydrolysis phase:

- Retention time: 5 d
- Organic loading rate: 38 $kg_{oDM}/(m^3 \cdot d)$

Digestion phase:

- Retention time: 15 d
- Organic loading rate: 3 $kg_{oDM}/(m^3 \cdot d)$

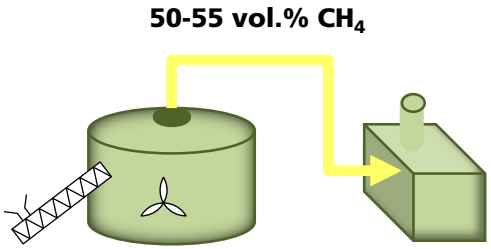
Fraunhofer UMSICHT

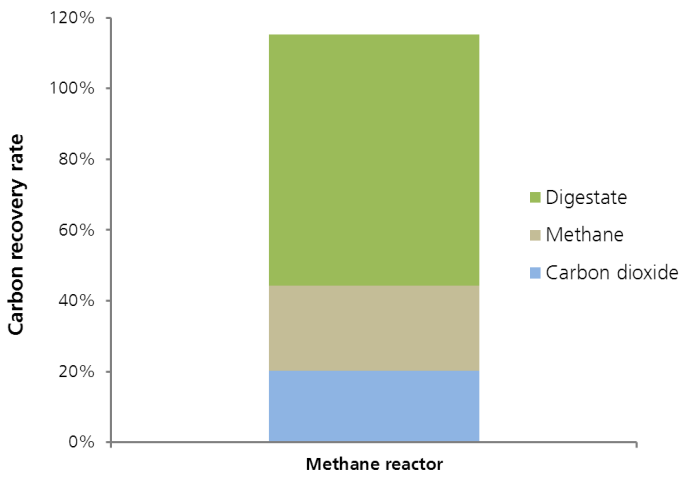
RESULTS AND DISCUSSION

Results and discussion

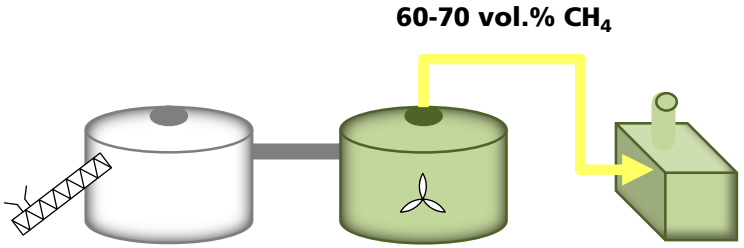
experimental trials – carbon mass balance

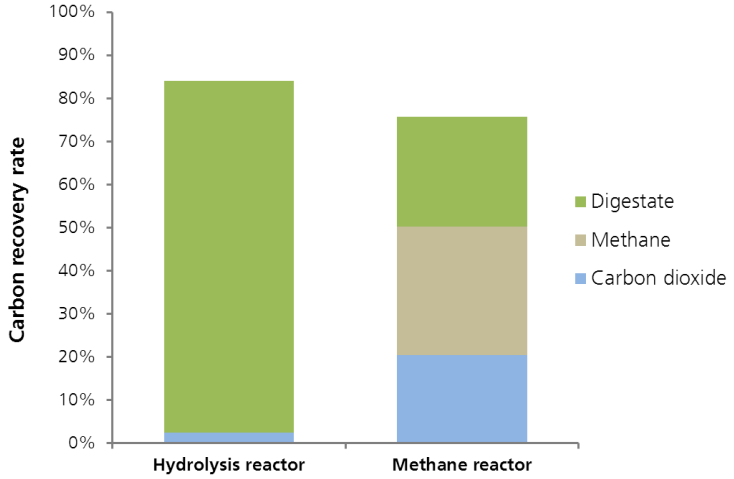
One-phase digestion





Two-phase digestion

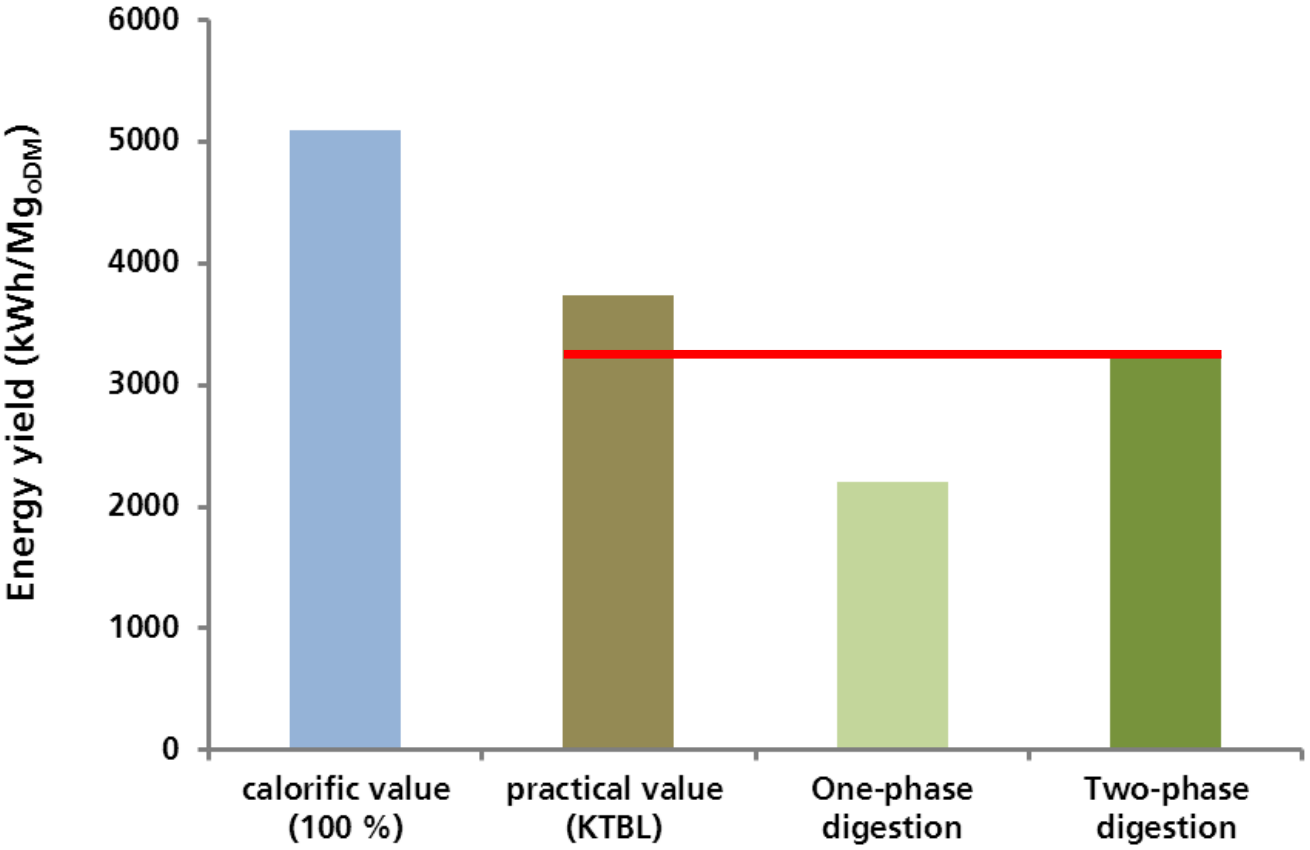




Fraunhofer UMSICHT

Results and discussion

Comparison of energy yield gas



Fraunhofer UMSICHT

CONCLUSIONS

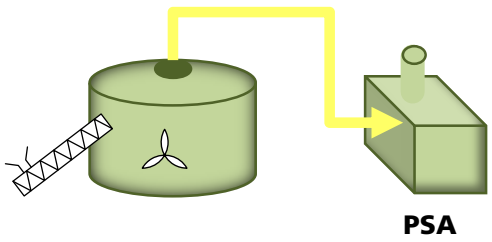
1
2
3
4
5

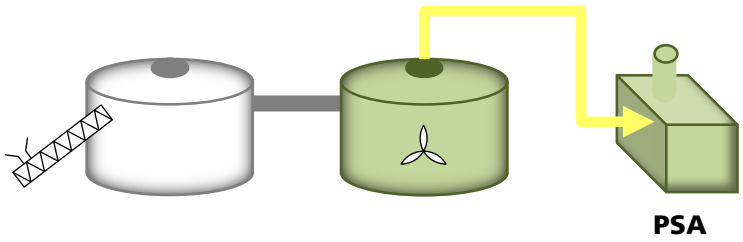
Fraunhofer
UMSICHT

Conclusions

Assets and drawbacks

One-phase digestion	Two-phase digestion





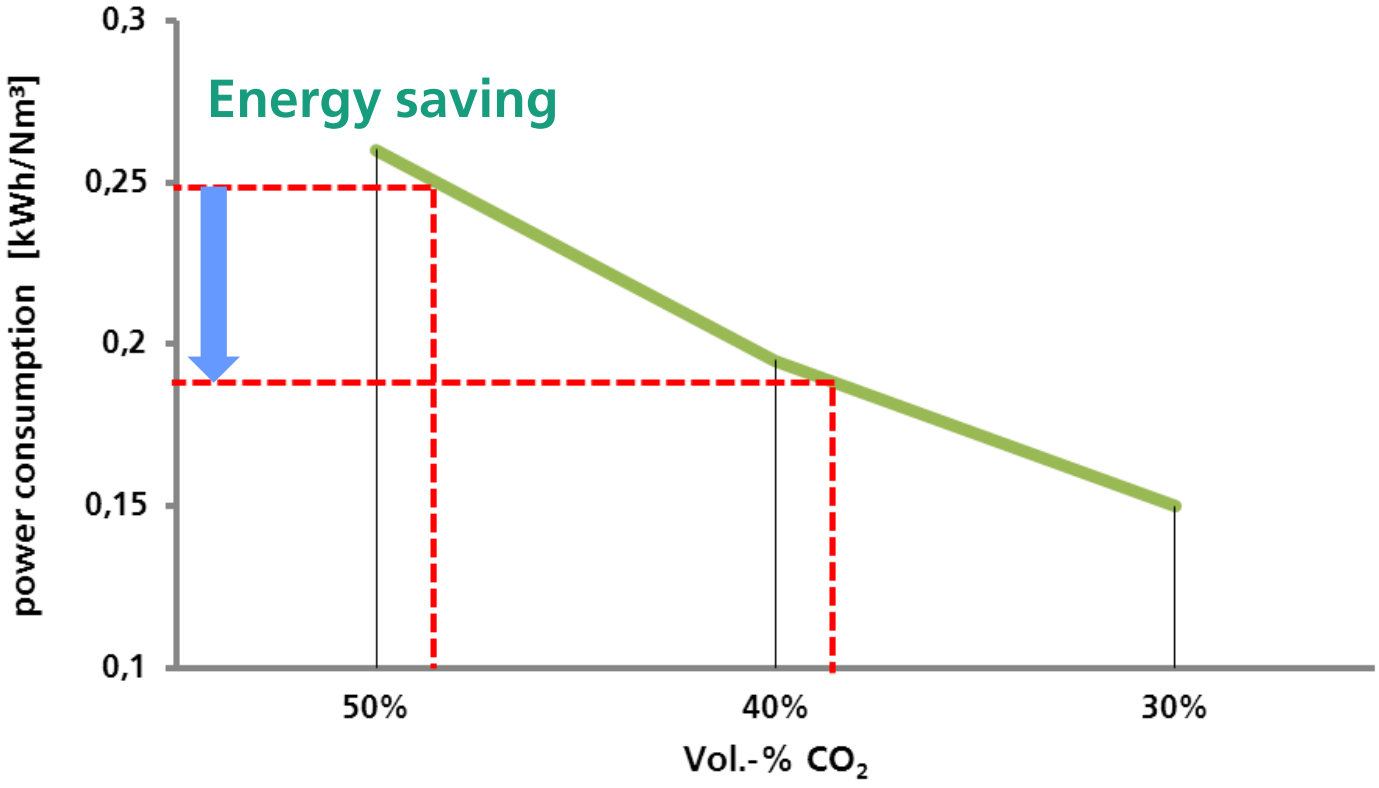
- Increase of methane concentration ✓
- Lower energy costs for biogas upgrading ✓
- Higher investment costs !
- Energy loss by hydrolysis gas (H_2) !

Fraunhofer UMSICHT

Conclusions

Outlook

- Comparison of power consumption for biogas upgrade



Fraunhofer UMSICHT

Energy efficient biogas upgrading by anaerobic hydrolysis

Contact:

Thank you very much!

Dipl.-Ing. (FH) Rolf Jung
recycling management

Fraunhofer UMSICHT
Institute branch Sulzbach-Rosenberg
An der Maxhütte 1
92237 Sulzbach-Rosenberg
Telefon: 09661-908-434
E-Mail: rolf.jung@umsicht.fraunhofer.de
Internet: http://www.umsicht-suro.fraunhofer.de

Funded by

e·on | Bioerdgas

Bayerisches Staatsministerium für
Wirtschaft, Infrastruktur, Verkehr und Technologie

Fraunhofer UMSICHT

Energy efficient biogas upgrading by anaerobic hydrolysis

Contact:

Thank you very much!

Dipl.-Ing.
recycling management

Fraunhofer UMSICHT
Institute branch Sulzbach-Rosenberg
An der Maxhütte 1
92237 Sulzbach-Rosenberg
Telefon: 09661-908-434
E-Mail: rolf.jung@umsicht.fraunhofer.de
Internet: http://www.umsicht-suro.fraunhofer.de

Funded by

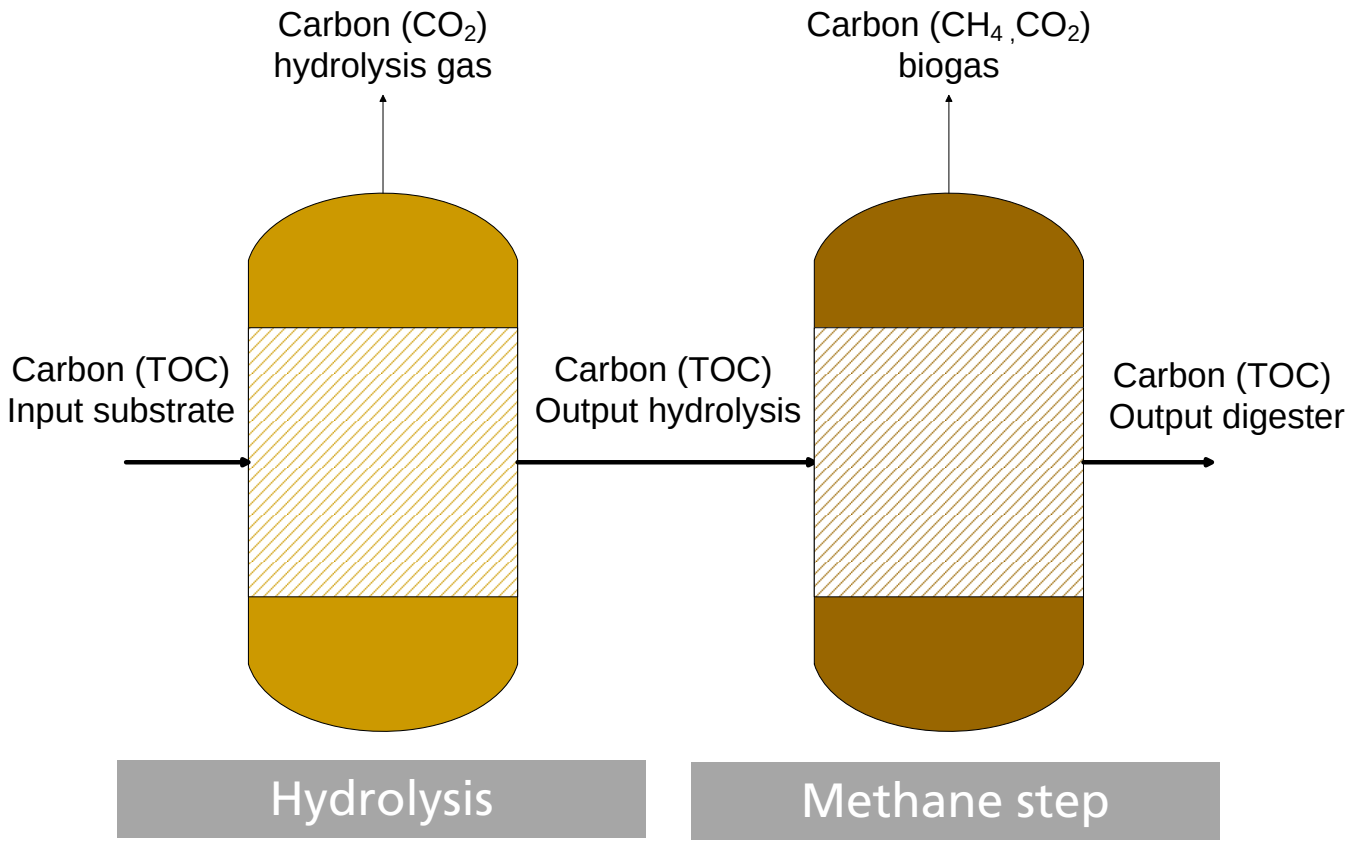
e·on Bioerdgas

Bayerisches Staatsministerium für
Wirtschaft, Infrastruktur, Verkehr und Technologie

Fraunhofer UMSICHT

Material and methods

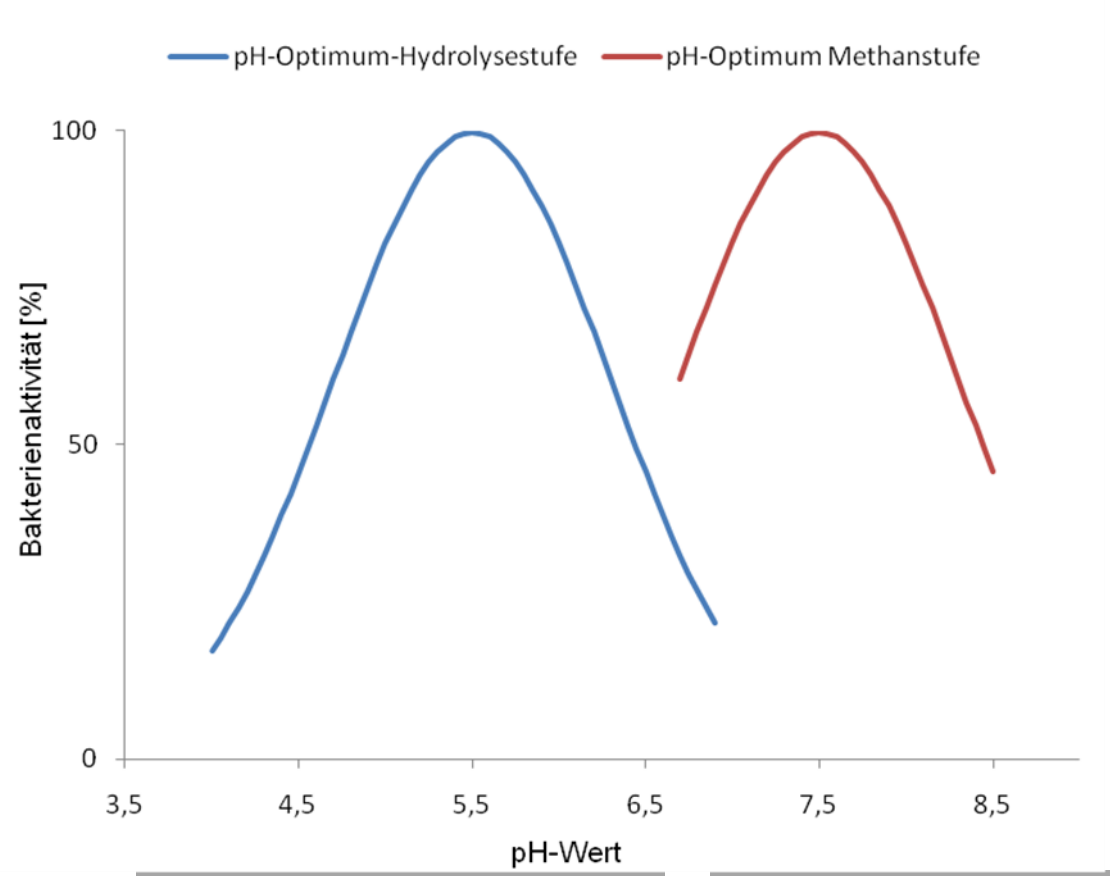
Carbon mass balance



Fraunhofer UMSICHT

Material and methods

pH and activity microorganism



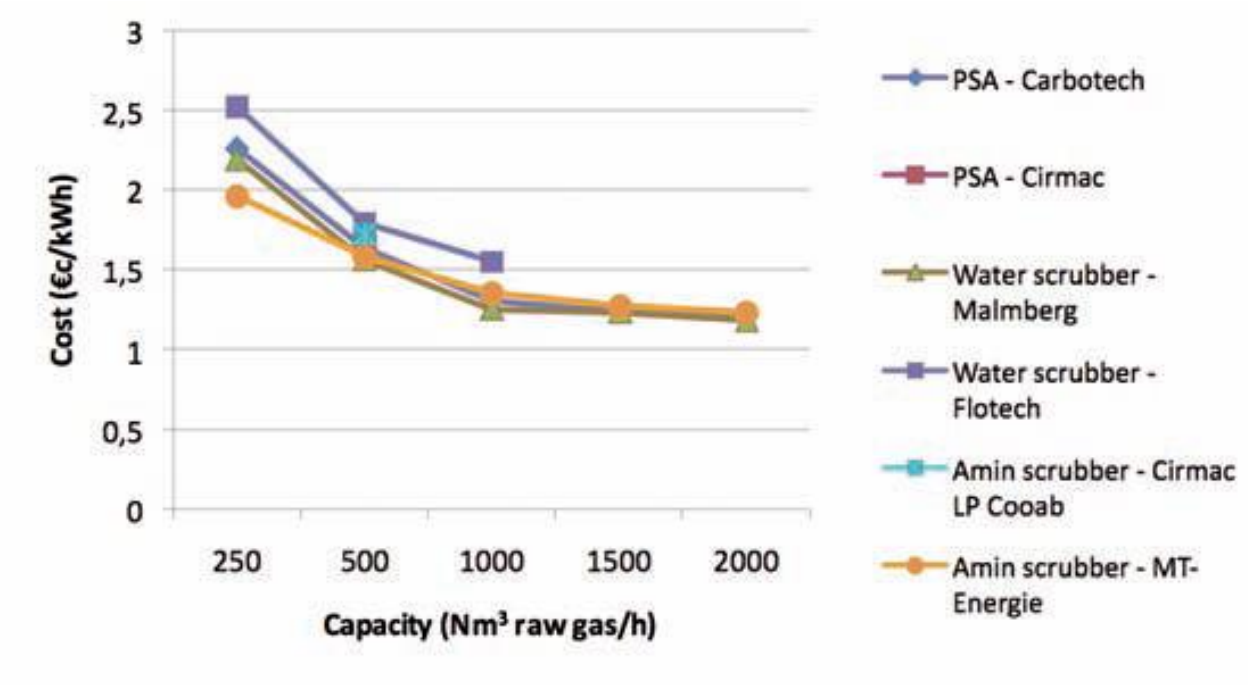
Hydrolysis

Methane step

Fraunhofer UMSICHT

Conclusions

xxx



Estimated cost of biogas upgrading using different technologies (Urban et al.2008).

Fraunhofer UMSICHT